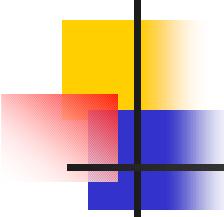


LQ search in eejj channel



Simona Rolli (TUFTS)



Introduction

- Some beyond the SM models assume additional symmetry between leptons and quarks
- LeptoQuarks – transition between leptons and quarks
 - Have both lepton and baryon numbers
 - λ - unknown coupling to leptons and quarks

LQ production at the TeVatron

■ Production

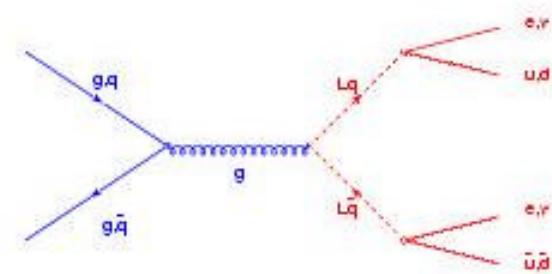
- $qg \rightarrow LQ + L\bar{Q}$
- $gg \rightarrow LQ + L\bar{Q}$
- $q\bar{q} \rightarrow LQ + L\bar{Q}$

■ Decay

- $LQL\bar{Q} \rightarrow l^+l^-q\bar{q}, l^\pm n\bar{q}q, nn\bar{q}\bar{q}$ $\beta = \text{Br}(LQ \rightarrow eq)$

■ Experimental signature:

- High pt isolated leptons (and/or MET) + jets



LQ production at TeVatron

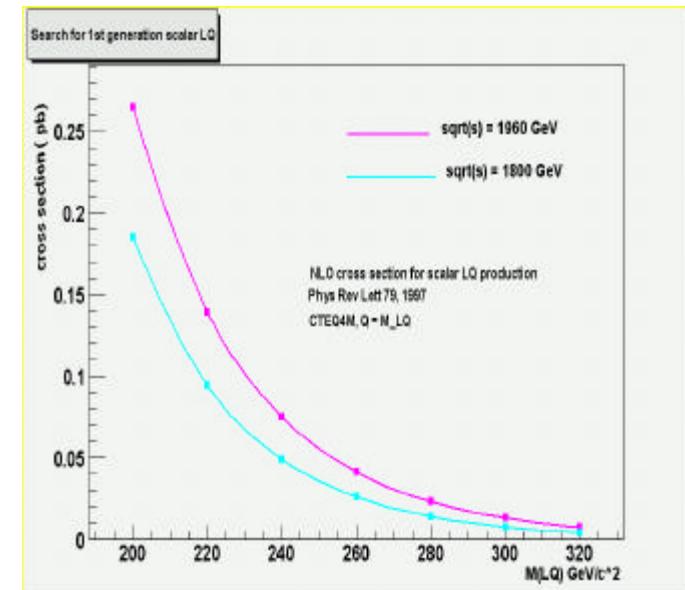
Code from Michael Kraemer (Phys.Rev.Lett 79,1997)

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.185E+00
220	0.094E+00
240	0.489E-01
260	0.259E-01
280	0.138E-01
300	0.746E-02
320	0.401E-02

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.265E+00
220	0.139E+00
240	0.749E-01
260	0.412E-01
280	0.229E-01
300	0.129E-01
320	0.727E-02

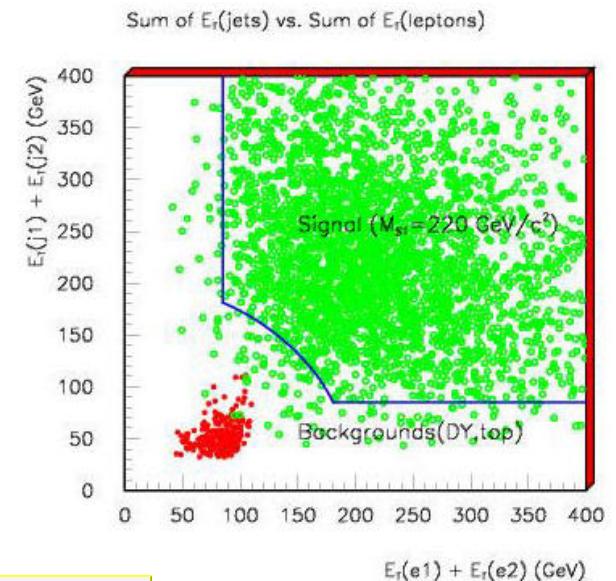
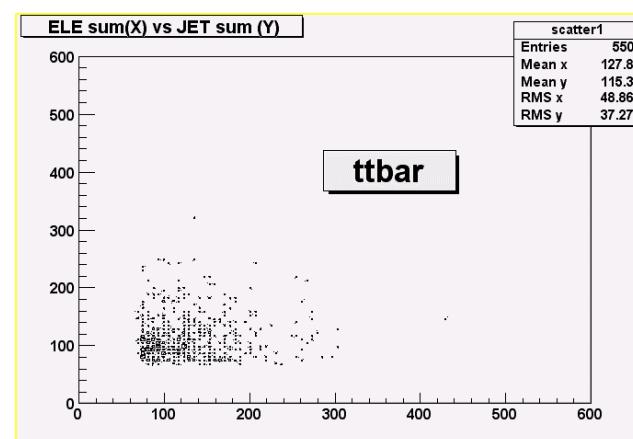
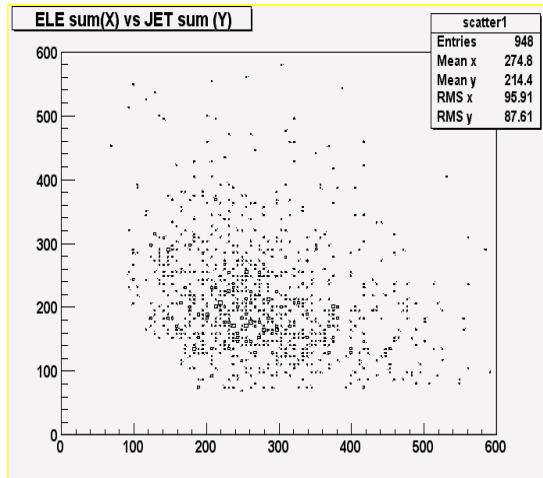
$\sqrt{s} = 1800 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf

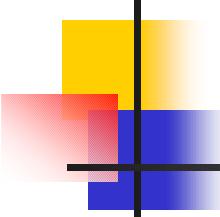
$\sqrt{s} = 1960 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf



LQ search in eejj

- 2 central electrons with $E_T > 25$ GeV
- 2 jets with $E_T(j1) > 30$ and $E_T(j2) > 15$ GeV
- removal of events with $76 < M_{ee} < 110$ GeV
- $E_T(j1) + E_T(j2) > 85$ GeV && $E_T(e1) + E_T(e2) > 85$ GeV
- $\tilde{\Omega}((E_T(j1) + E_T(j2))^2 + (E_T(e1) + E_T(e2))^2) > 200$ GeV

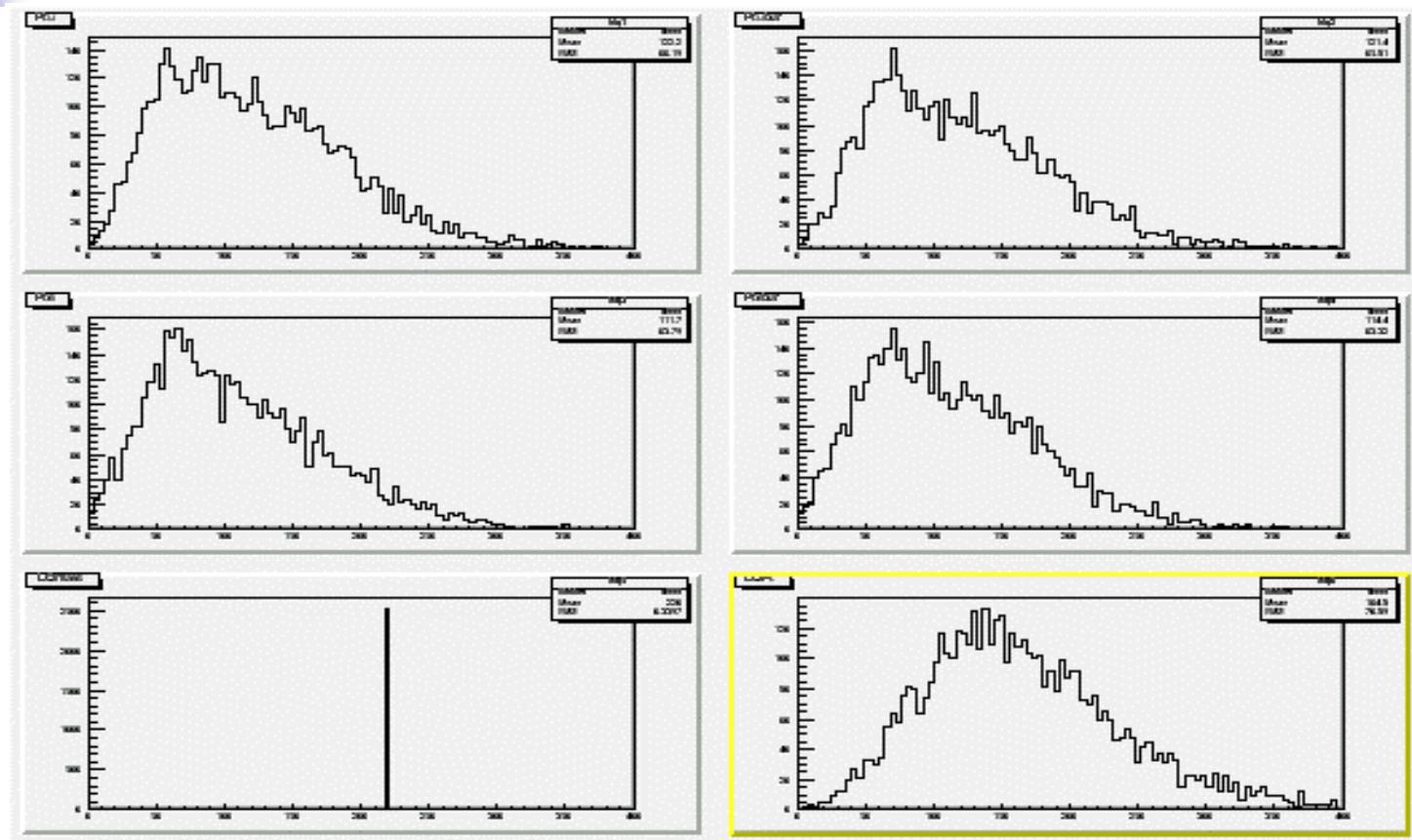




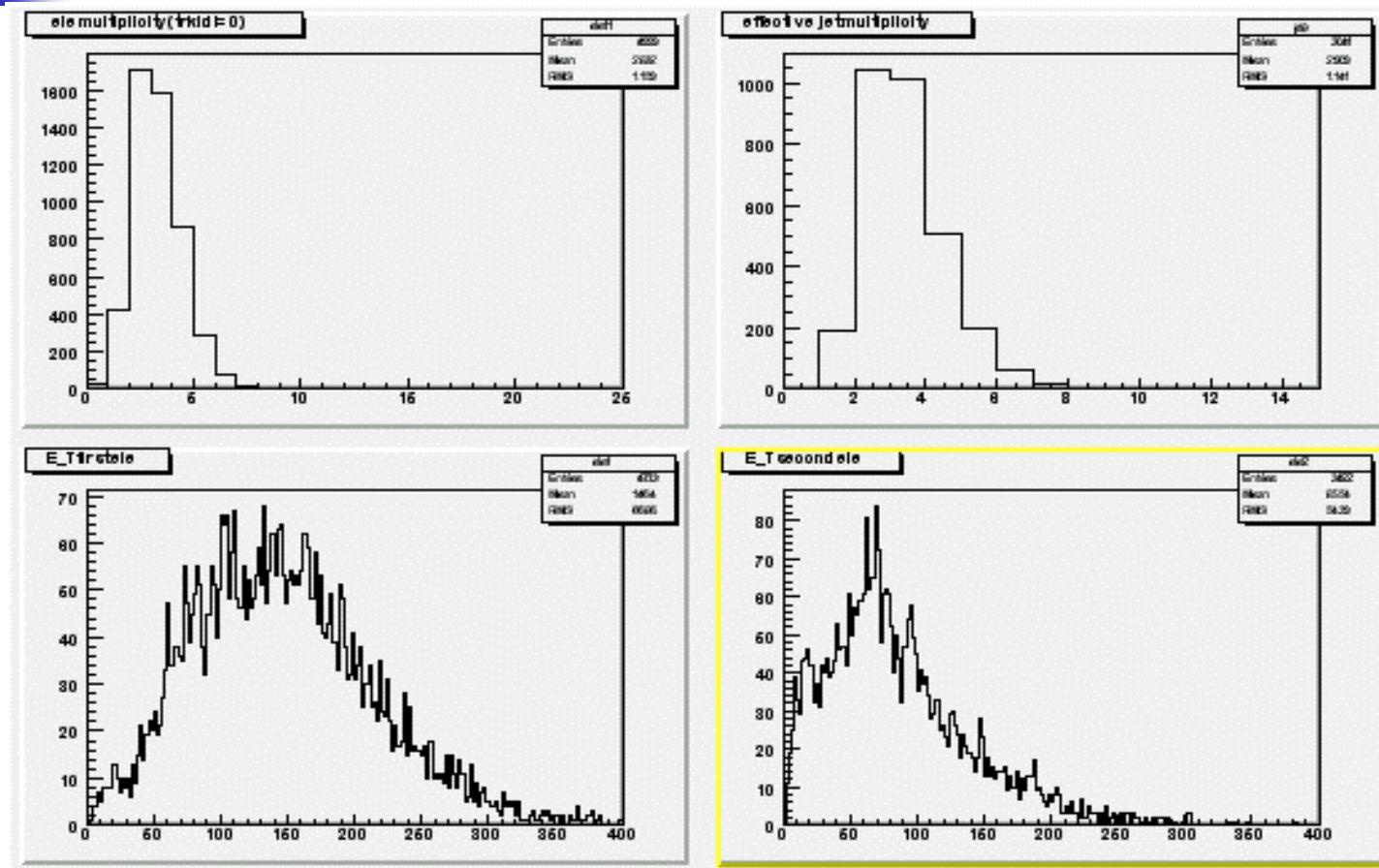
Tools

- Signal generated and reprocessed with 4.9.1
 - 5000 events at masses from 200 to 320
 - run number 151435
 - full beam position
 - talk GenPrimVert
 - BeamlineFromDB set false
 - sigma_x set 0.0025
 - sigma_y set 0.0025
 - sigma_z set 28.0
 - pv_central_x set -0.064
 - pv_central_y set 0.310
 - pv_central_z set 2.5
 - pv_slope_dxdz set -0.00021
 - pv_slope_dydz set 0.00031
 - exit
- eN (4.9.1)used for ntuple analysis
 - <http://ncdf70.fnal.gov:8001/talks/eN/eN.html>

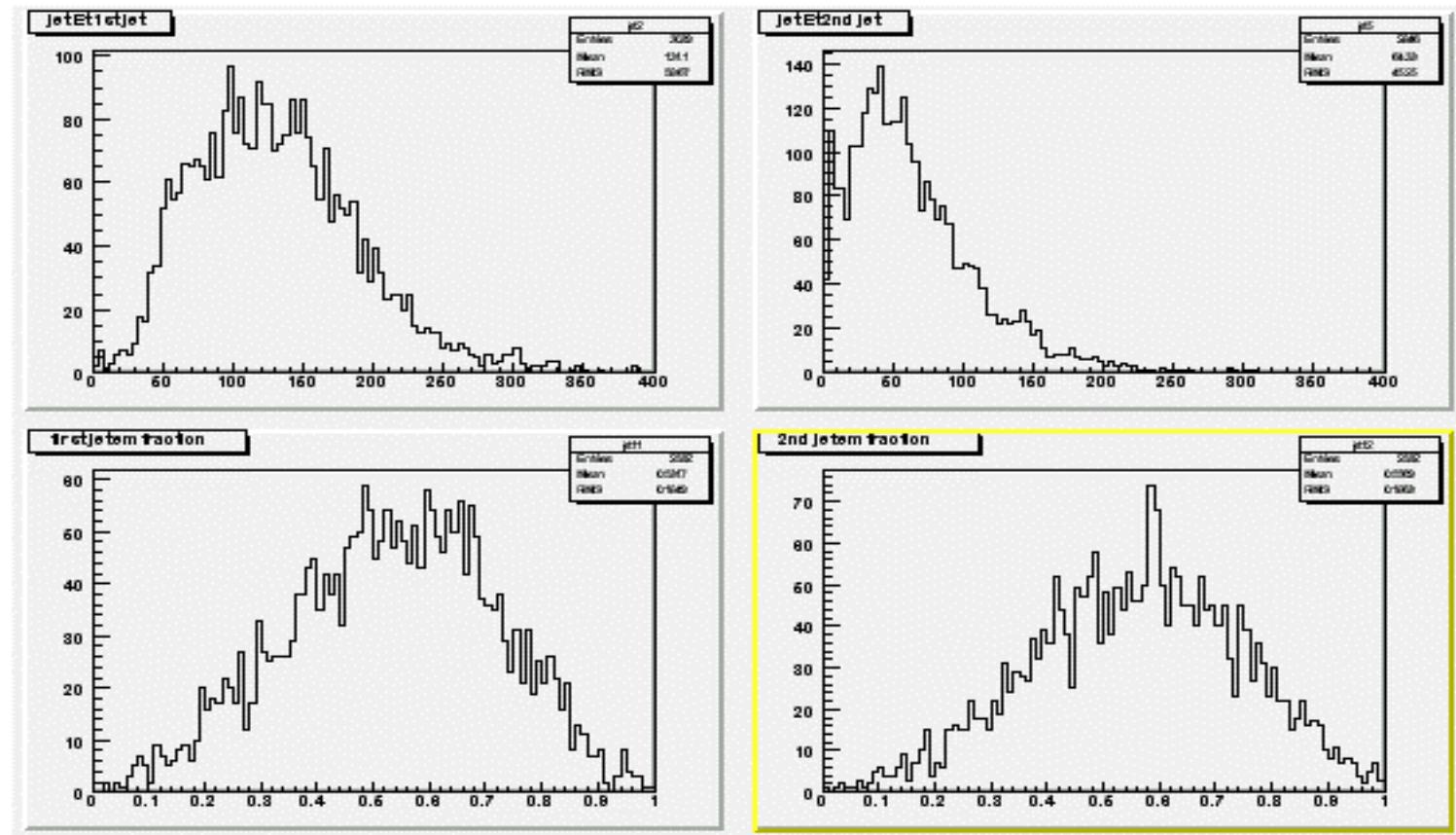
MC distributions ($M_{LQ} = 220$)

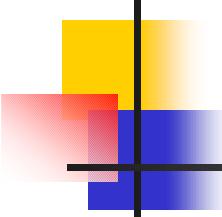


MC distributions ($m_{LQ} = 220$)



MC distributions (cont'd)

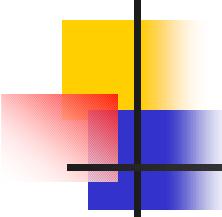




Efficiencies & acceptance

$$\epsilon_{\text{tot}} = \epsilon_{\text{Acc}}(M) \times \epsilon_{\text{ID}} \times \epsilon_{z0} \times \epsilon_{\text{trig}}$$

- Trigger
 - Top/EW - as in Z' analysis we use $99.1 \pm 0.1\%$
- Efficiencies for electron selection cuts
 - Z' analysis
 - $\epsilon_{\text{CC}} = 84.4 \pm 0.8$
- Other
 - efficiency on the vertex cut ($|z_0| < 60$ cm) 95.2 ± 0.1 (stat) ± 0.5 (sys) (Willis Sakumoto)



Electron ID (Z' analysis)

- Central electron (loose or tight)

- $E_t \geq 25 \text{ GeV}$
- $p_t > 13 \text{ GeV}$
- $\text{hadem} \leq 0.055 + 0.00045 * E$
- $E/p < 4$ (for $Pt < 50 \text{ GeV}$)
- $\text{iso4e}/\text{emet} < 0.1$ (0.2 for second central loose)
- $|\Delta x| < 3.0$
- $|\Delta z| < 5.0 \text{ cm}$
- Fiducial = 1
- $I_{\text{sh}} < 0.2$

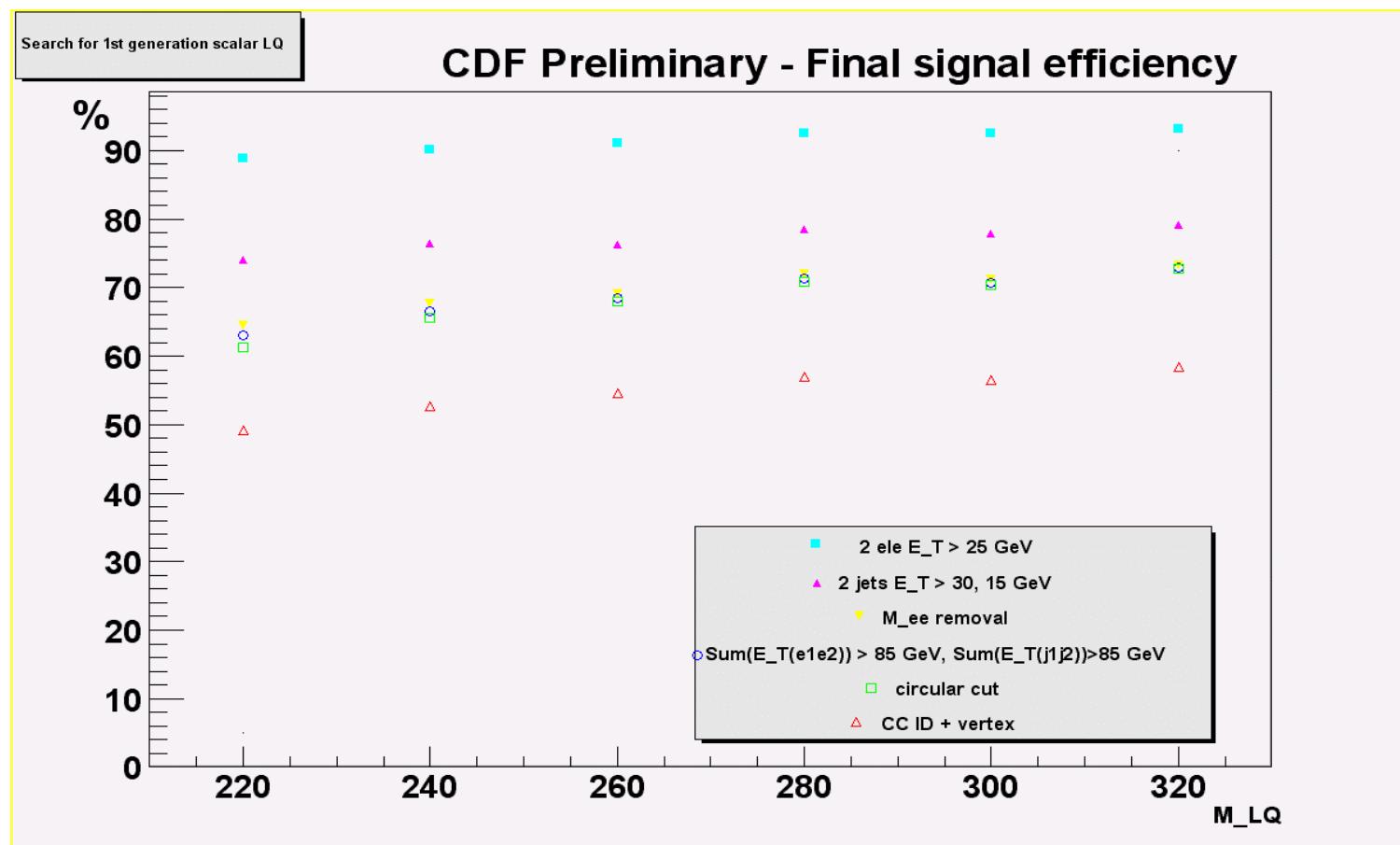
$$\epsilon_{CC} = 84.4 \pm 0.8\%$$

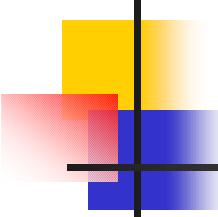
$$\epsilon_{CP} = 69.3 \pm 0.8\%$$

Second Loose Plug electron
(not used in this analysis)

- $E_t \geq 25 \text{ GeV}$
- Isolation < 0.1
- $\text{hadem} \leq 0.055 + 0.00045 * E$
- Fiducial $1 < |\eta| < 3$

Total acceptance

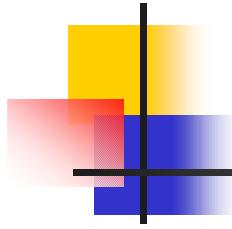




Total kinematical acceptance

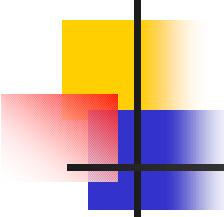
M_{LQ} (GeV/c ²)	200	220	240	260	280	300	320
2 ele with $E_T > 25$ GeV	0.873±0.006	0.888±0.005	0.905±0.005	0.911±0.005	0.925±0.004	0.924±0.004	0.932 ±0.004
2 jets with $E_T > 30, 15$ GeV	0.723±0.008	0.740±0.007	0.768±0.008	0.763±0.007	0.785±0.007	0.777±0.007	0.790± 0.006
M_{ee} removal cut	0.625±0.009	0.644±0.008	0.685±0.008	0.690±0.008	0.712±0.008	0.711±0.008	0.731±0.008
$\Sigma(E_T(\text{ele}_i)) > 70$ GeV & $\Sigma(E_T(\text{jet}_i)) > 70$ GeV	0.604±0.009	0.639±0.008	0.674±0.009	0.684±0.008	0.712±0.008	0.706±0.008	0.729± 0.008
$\Sigma(E_T(\text{ele}_i) + E_T(\text{jet}_i)) >$ 200	0.574±0.009	0.612±0.008	0.664±0.009	0.679±0.008	0.709±0.008	0.703±0.008	0.727± 0.008

	M_{LQ}	Exp(70.2 pb ⁻¹)
Number of expected events in 70.2 pb ⁻¹	200	8.6 ± 0.5
	220	4.8 ± 0.3
	240	2.8 ± 0.2
	260	1.6 ± 0.1
	280	0.9 ± 0.1
	300	0.5 ± 0.1
	320	0.3 ± 0.2



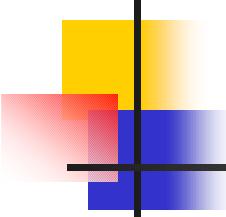
Background

- tt with both $W \rightarrow e\nu$ 0.25 ± 0.03 events
 - pythia
- DY + 2 jets 3.13 ± 2.8 events
 - alpgen + PS
- Total 3.39 ± 3.15



Data sample

- btop0g (inclusive electrons) stripped from bheI08 and (4.8.4 Production)
- Inclusive-ele_484_REMAKE
- events selected from Ele_18 && Ele_70 triggers
- good runs from March 23 2002 to Jan 12 2003 (141544 - 156487)
- 70.2 pb^{-1}
 - 2 isolated electrons
 - One tight (central)
 - One loose (central)
 - At least 2 energetic jets



Data sample

```
module clone Prereq HPTE
module enable Prereq-HPTE
module talk Prereq-HPTE
  L1Accept set true
  L2Accept set true
  L3Accept set false
  L3TriggerNames set ELECTRON70_L2_JET \
    ELECTRON_CENTRAL_18 \
    ELECTRON_CENTRAL_18_NO_L2 \
    W_NOTRACK \
    W_NOTRACK_NO_L2 \
    Z_NOTRACK
  debug set false
exit
exit
```

```
module clone StripSingleE HPE2
module enable StripSingleE-HPE2
module talk StripSingleE-HPE2
  elePtMin set 15.0
  etCalMin set 70.0
  delXMin set 3.0
  delZMin set 5.0
  show
exit
```

```
module clone StripSingleE HPE1
module enable StripSingleE-HPE1
module talk StripSingleE-HPE1
  elePtMin set 9.0
  etCalMin set 18.0
  delXMin set 3.0
  delZMin set 5.0
  EoPMax set 4.0
  lshrMax set 0.3
  hademMax set 0.125
  show
```

Z cross section check

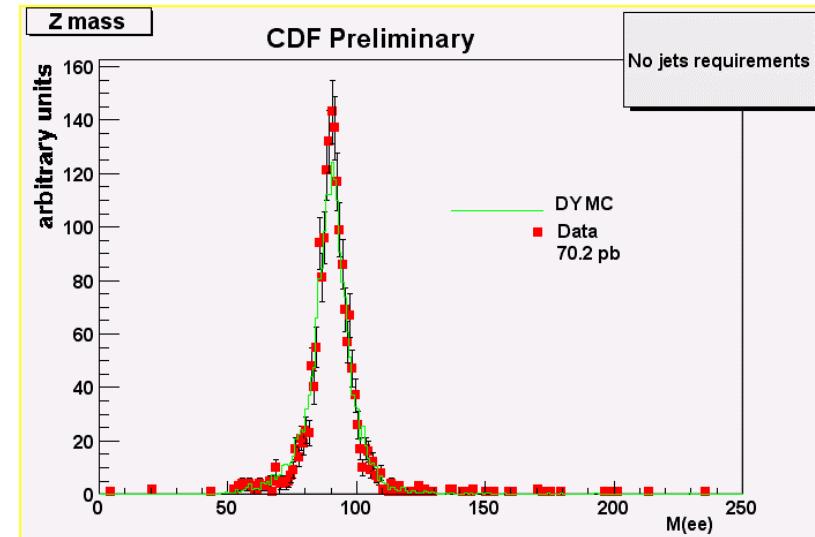
- Z boson candidates selected by requiring:

$$70 \text{ GeV} < M_{ee} < 110 \text{ GeV}/c^2$$

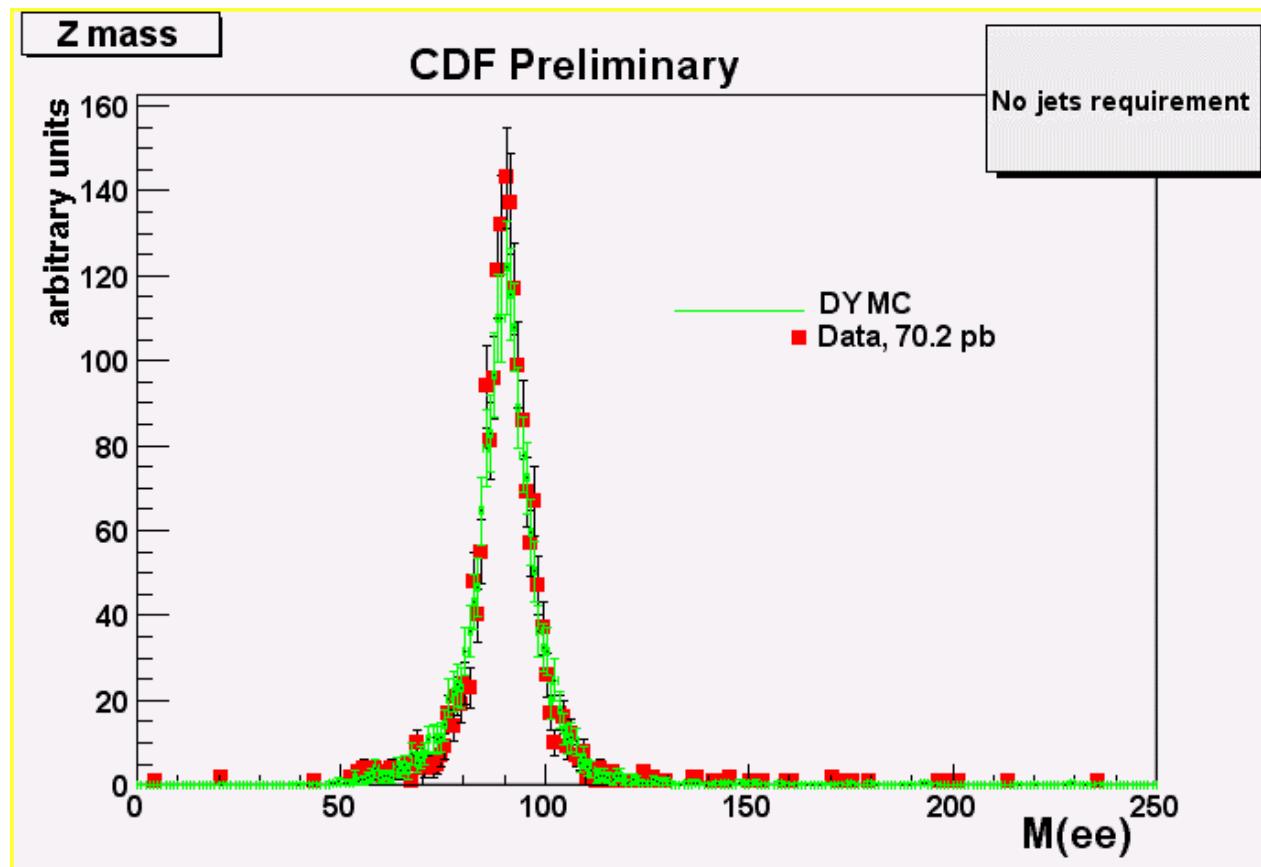
- Central-Central candidates: 1824
- Cross section is calculated as:

$$s \cdot \text{Br} (\text{pp} \rightarrow Z \rightarrow e^+e^-) = (N_Z - N_{\text{BG}}) / (A_Z \cdot e_{\text{ID}} \cdot e_{\text{trig}} \cdot e_{z0} \cdot L)$$

Acceptance	$12.7 \pm 0.7\%$
ID efficiency	$84.4 \pm 0.8\%$
trigger efficiency	$99.9 \pm 0.1\%$
Z_0 efficiency	$95.2 \pm 0.5\%$
Observed events	1806
estimated bkg	34.8 ± 21.1
integrated L	70.2 ± 0.7
Z cross section	$247.50 \pm 14.3 \text{ pb}$



Z mass

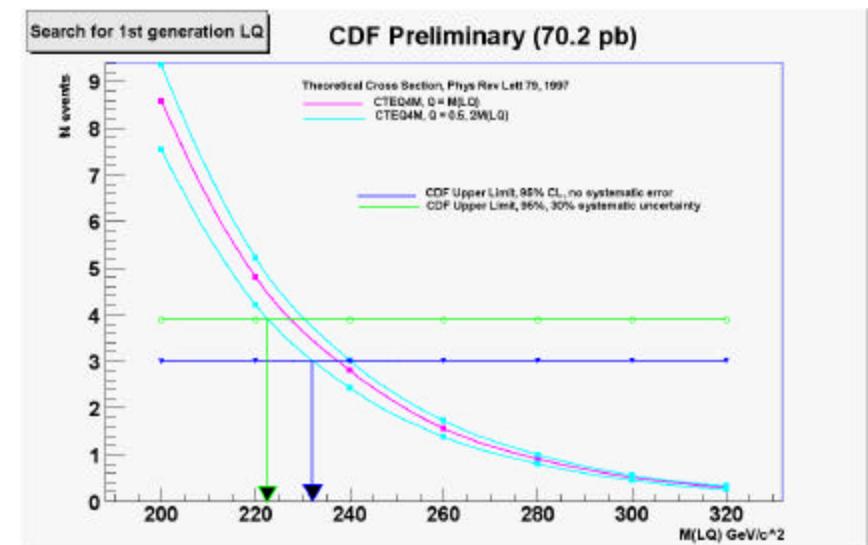


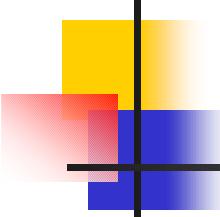
Analysis results

0 events survive the analysis cuts:

Number of events with 2 ele > 25	1970
2 jets with $E_T(j1) > 30$ and $E_T(j1) > 15$ GeV	27
removal of events with $76 < M_{ee} < 110$ GeV	9
$E_T(j1) + E_T(j2) > 85$ GeV && $E_T(e1) + E_T(e2) > 85$ GeV	2
$\sqrt{(E_T(j1) + E_T(j2))^2 + (E_T(e1) + E_T(e2))^2} > 200$ GeV	0

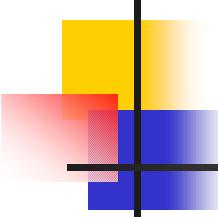
$M_{LQ} > 233$ GeV/c² @ 95% CL
(run I 220 GeV/c²)





LIMIT No systematics

Mass	95%CL sigma (pb)	sigma_Theory CTEQ4M (pb)	
		$Q^2 = M^2/4$	$Q^2 = 4M^2$
<hr/>			
200	0.0926792	0.289	0.233
220	0.0868641	0.151	0.122
240	0.0809793	0.0815	0.0657
260	0.0783241	0.0449	0.036
280	0.0750778	0.025	0.02
300	0.0756357	0.0141	0.0112
320	0.0731389	0.00799	0.00629

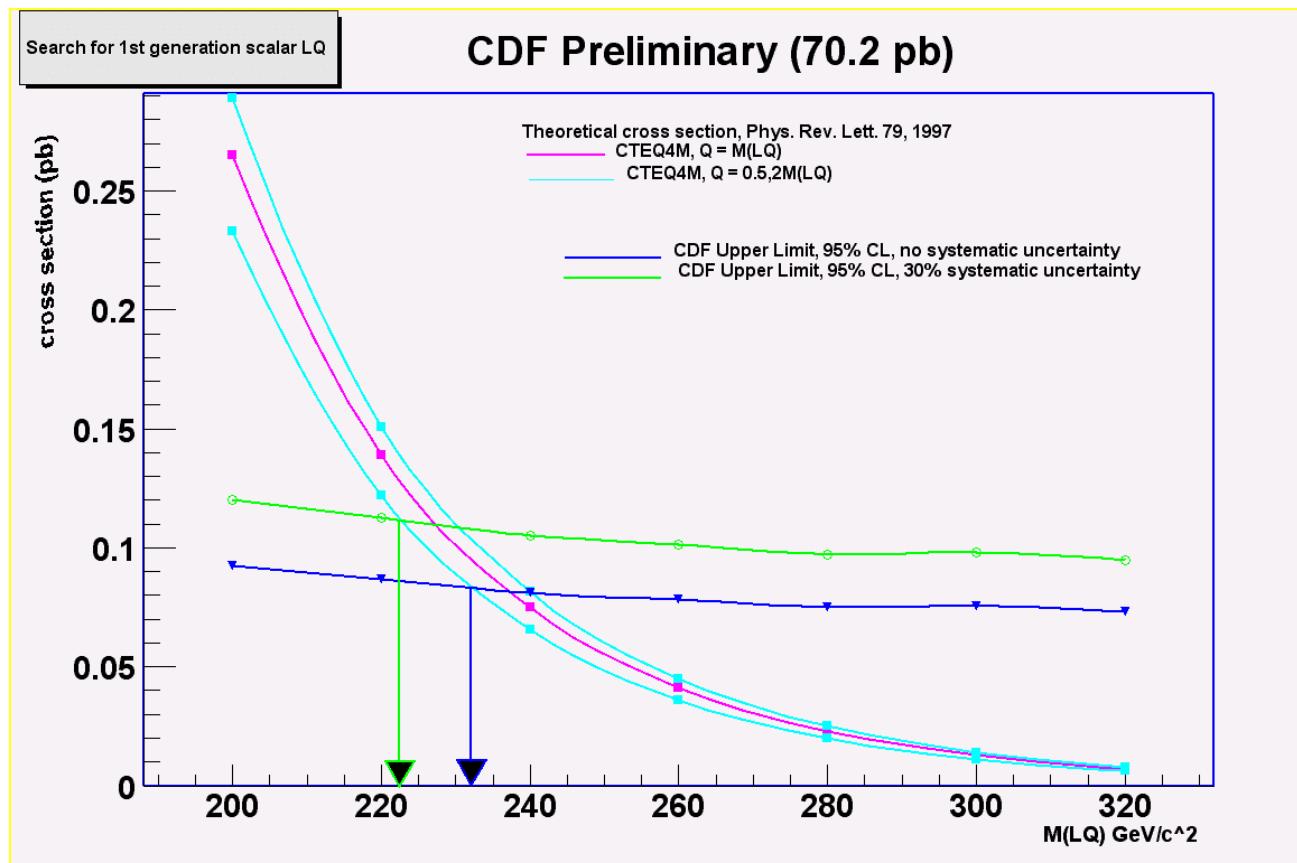


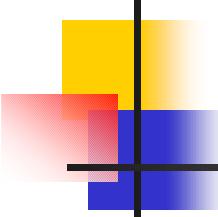
LIMIT 30% added systematic

Mass	95%CL sigma (pb)	sigma_Theory CTEQ4M (pb)	
		$Q^2 = M^2/4$	$Q^2 = 4M^2$
<hr/>			
200	0.120409	0.289	0.233
220	0.112654	0.151	0.122
240	0.105189	0.0815	0.0657
260	0.101526	0.0449	0.036
280	0.0972684	0.025	0.02
300	0.0980164	0.0141	0.0112
320	0.094788	0.00799	0.00629

25% increase in the cross section
~factor 1/3 less luminosity
acceptances slightly higher

Cross section Limit

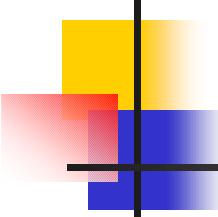




Systematic uncertainties

- Luminosity: 10%
- Acceptance
 - pdf 4.3% (from run I)
 - statistical error of MC 2.2%
- Electron ID efficiency
 - statistical error of $Z \rightarrow e^+e^-$ sample: 0.8%
 - energy scale : 3.7%
- Event vertex cut : 0.5% (Willis)
- Energy scale on : ?
- Jet energy scale : uncorrected jets are used now

Work in progress



Conclusions

- A preliminary upper limit has been set on the mass of scalar LeptoQuark of first generation:

$$m_{LQ} > 233 \text{ GeV/c}^2$$

with no systematics.

CdfNote 6338 (out by Monday)

work on systematics (mostly from jet corrections ongoing)